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VERTEBRATE FAUNA OF THE SILVERBAND FORMATION, GRAMPIANS, WESTERN VICTORIA

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Abstract: Scales from the Grampians Group of western Victoria, previously reported as shark denticles, are predominantly those of a new species of turiniiform thelodont, *Turinia fuscina*, similar to those of the Late Silurian-Early Devonian *Turinia pagei* (Powrie), and possibly those of an ischnacanthiid acanthodian, possibly *Gomphonchus*. Tooth whorls in the Silverband Formation probably also belonged to *Gomphonchus*. Fin spines, identified hitherto as the elasmobranch *Physonemus*, are possibly climatiid acanthodian remains; they resemble those of *Sinacanthus* from the Siluro-Devonian of China. An alternative interpretation of some of the scales and spines as those of an elasmobranch similar to *Antarctilamna* is considered. The age of the Silverband Formation is reassessed in the light of the new identifications of the vertebrate remains, and the environment of the fauna is discussed. Based on the presence of turiniiform scales an age range for the Silverband Formation from Gedinnian into early Frasnian is possible.

In 1917 Ferguson recorded the first fossils in the Grampians Group of western Victoria. He had found invertebrates and vertebrate macrofossils from one locality on the Stairway track to Mount Rosea in Unit 3 of the Silverband Formation (Ferguson 1917, Spencer-Jones 1965). Chapman (1917) identified the fauna as including "worm burrows", *Lingula squamiformis* Phillips *var. borungensis*, which "formed sheets on the bedding planes", and elasmobranch fin spines *Physonemus attenuatus* Davis and *Physonemus micracanthus* sp. nov.

As Spencer-Jones put it, Chapman "confidently gave a Lower Carboniferous age to these fossils" on the basis of the fin spines and brachiopods (Spencer-Jones 1965). The age determination and status of Chapman's identification of the *Lingula* species were queried, and from them only an inconclusive Devonian or Carboniferous age was extracted (Talent & Spencer-Jones 1963). Talent and Spencer-Jones (1963) discovered and described further material from six localities in Unit 3 and showed that Chapman's assessment of the age and content of the Silverband fauna was erroneous. The "worm burrows" were probably linguloid; the species of *Lingula* was unlike that of the Upper Devonian/Early Carboniferous; the spines were not those of *Physonemus* (Baird 1957, Talent & Spencer-Jones 1963). New finds of ostracodes and fish scales and teeth were described. Talent and Spencer-Jones still considered the vertebrate remains to be those of sharks and retained the use of '*Physonemus*' for the spines. They attempted to relate the scales they found to shark dermal denticles then known from the Palaeozoic but were not able to resolve them beyond Order Cladoselachii or Selachii. At that time shark remains were thought to be unknown in sediments older than Middle Devonian. Thus Talent and Spencer-Jones set a lower limit to the age of the Silverband Formation of Middle Devonian while retaining the suggested possible age of Upper Devonian through Lower Carboniferous (Spencer-Jones 1965, 1976).

Spencer-Jones (1976) summarized the fauna as *Lingula borungensis* (Chapman), two smooth ostracodes, spines of '*Physonemus*' *micracanthus* (Chapman), elasmobranch dermal denticles and teeth of apparent elasmobranch affinities. The *Lingula* band occurs within thin purplish siltstones cropping out beneath the cliffs of the Wonderland Range whereas the fish and ostracodes occur together in Unit 3 beds south of Middleton Peak in the Serra Range and southwards to Mirranatwa Gap; ostracodes also occur in beds beneath Briggs Bluff and in the Asses Ears anticline (Spencer-Jones 1976, fig. 4.10).

THE SILVERBAND FISH FAUNA

The fish remains in the samples of Unit 3 of the Silverband Formation are preserved in a thin band of orange to pink quartzite. The scales and spines are chalky white and very friable and can only be prepared by mechanical means. The quartz grains are poorly cemented allowing the smaller scales to be removed from the matrix with a fine needle. Because of the nature of the material it has not been possible to see the larger specimens of scales, 'teeth', and spines in the round, and thin sectioning to examine histological structure has not been attempted. For these reasons it is not easy to decide on the identity of the remains, other than the small scales, with any degree of certainty. Therefore I am presenting alternative explanations for some of the remains. There are then two possible conclusions about the age of the Silverband Formation within the overall time span governed by the presence of turiniid remains. Only the discovery of better-preserved material will help to resolve the dichotomy.

Most of the smaller (<1.00 mm) scales from the Silverbank Formation are not from elasmobranchs but belonged to the jawless fish called thelodonts. The fin spines, a few of the larger scales, and the tooth whorls can also be interpreted as non-elasmobranch remains. In 1981 I investigated the scales in the type material, having considered that the scales portrayed by Talent and Spencer-Jones were unlike those of any Devonian *shark* but were more akin to thelodont scales (Turner 1982a). Agnathan thelodonts were common elements of littoral and fluvial environments from the Early Silurian through to Late Devonian and were widespread especially in the Early into Middle Devonian (e.g. Turner 1973, Tarling & Turner 1982). Shark scales are now known in the Late Silurian and Early Devonian but none is exactly like the simple placoid scales of thelodonts (Karatajute-Talimaa 1973, 1977, Vieth 1980). The Silverband scales belong to the genus *Turinia*, a thelodontid which is common in shallow-water Devonian sediments. The scales are referred here to a new species which is considered to be close to *T. pagei* (Powrie 1870) of the upper Pridoli and Lower Devonian of Europe and parts of North America, although in some features they resemble other Australian turiniid species.

A few scales observed in the Silverband Formation samples appear to be those of an acanthodian like *Poracanthodes* of Brotzen (1934); these scales are considered to be special scales of an ischnacanthid named *Gomphonchus* by Gross (1971a; Denison 1979). Alternatively, these larger scales might be those of a shark akin to *Antarctilamna* Young 1982.

The tooth whorls figured by Talent and Spencer-Jones (1963, pl. 11, figs 2, 3, 8) are also interpreted as those of an acanthodian. Many Early Devonian ischnacanthids possessed such tooth whorls, and even some climatiids such as *Nostolepis* are thought to have done so (Gross 1971a, Denison 1979). Other early bony fishes, such as onychodontid crossopterygians, also possessed tooth whorls, but in the absence of the typical conical teeth their presence is ruled out.

The fin spines are seen preserved in lateral view or in cross-section (Talent & Spencer-Jones fig. 3, pl. 11, figs 4-8). They are not like those of any Palaeozoic shark and are quite unlike those of *Physonemus* (St John & Worthen 1875, Baird 1957). One of the spines figured by Talent and Spencer-Jones (1963, pl. 11, fig. 5) is long and slender and might be that of an ischnacanthid (see Denison 1979). The other spines are relatively broad and arcuate, with a number of straight or slightly nodose dentine ribs along the exposed shaft, and have no obvious inserted portion. The illustrations given by Chapman (1917, pl. V, figs 1-3) seem to exaggerate the nodose ornament of the dentine ribs. The fin spines are similar to those of climatiids, and some referred to *'Onchus'* (Denison 1979). Fin spines similar to these have been recorded by Young (1985) from the Amadeus Basin. However, the spines seem most like those called *Sinacanthus* P'an 1957, known from the Silurian and Early Devonian of China (Li 1980, Liu 1983). An alternative explanation, again based on overall shape and the poorly-preserved histological structure, is that the spines do belong to a shark akin to *Antarctilamna*.

ENVIRONMENT OF THE SILVERBAND FORMATION

Several early workers noted the similarity of the Silverband Formation and other sediments of the Grampians Group to the Old Red Sandstone of Britain (Chapman 1917, footnote 2). Talent and Spencer-Jones (1963) considered that Silverband Formation fauna was a "restricted fauna with marine affinities", with an overall assessment that the sediments of the Grampians Group are predominantly freshwater. Unit 3 consists of 55 m of purplish-red, yellow or grey micaceous siltstone with some mudstone, containing 'clay galls', mudcracks and animal burrows. The combination of trace fossils, lingulids, ostracodes and fish is a common one in the Palaeozoic (Denison 1956). Allen (1985) described this combination as typical of the lower part of the Downton beds of the Welsh Borderland. Talent and Spencer-Jones regarded the Silverband fauna as a shallow-marine fauna, although Spencer-Jones (1965, p. 69) pointed out that the "appearance of mud cracks and clay galls is evidence that at some stage the sediments were above water level for sufficient time to allow desiccation" and implied tidal action was involved. The fish remains are scattered in small patches among the quartz grains of the sandstone band which probably forms the base of a purplish-red siltstone. The grains are subrounded and not strongly cemented. The thelodont scales are small by comparison with those of most other turiniid species. This decline in scale size has been observed elsewhere in sediments thought to be of hyposaline origin, as in the dolomitic limestones of Arctic Canada for instance (Turner pers. obs.).

According to Spencer-Jones (1976), the Grampians Group red beds are thickest in the Silverband Formation which he interpreted as possibly implying a period of slower sedimentation in a humid or semi-arid climate. The *Lingula* shells are disarticulated and mostly broken. Fragments of shells with pieces of fish spine are often associated with sediment in mudcracks. Chapman (1917) noted that the *Lingula* shells were often "crowded together in veritable sheets, having evidently drifted into small pools by tidal action". Spencer-Jones (1976) regarded these facts, associated with the mudcracks and clay galls, as indicating periodic desiccation and tidal action which would also concur with an estuarine or deltaic environment.

These facts gleaned from the sediments and the impoverishment of the fauna would seem to indicate that Unit 3 of the Silverband Formation was not formed in a typical marine environment but probably reflect hyposaline or brackish conditions, formed within an estuarine or intertidal environment (cf. Allen 1985). Plant remains of undoubted freshwater or terrestrial origin are present in the Grampians Group but occur some 3000 m above the Silverband Formation (Spencer-Jones 1965).

The association of thelodonts, climatiid and ischnacanthiid acanthodians, lingulids and ostracodes is not unusual in the Late Silurian and Early Devonian of the northern hemisphere (e.g. Denison 1956, Turner 1973, Märss & Einasto 1978). Märss and Einasto (1978) have assessed the environmental significance of the association and dominance of various elements in the very complete Early to Late Silurian sequence in Saaremaa. They regarded a combination of dominant thelodont scales with few acanthodian scales typical of near-shore conditions. Thus, whatever the actual sedimentary provenance of the Silverband Formation, it is reasonable to assume that the fish whose remains are found in Unit 3 were living in a shallow water, nearshore environment. After death their remains were swept into

Fig. 1—Location of major finds of thelodontids in Australia. Places marked—AS, Alice Springs; B, Brisbane; C, Canberra; M, Melbourne; P, Perth; S, Sydney. Brick motif for limestones; dots for sandstone/siltstones.

shallows possibly on the floodplain of the nearby continental shoreline.

Most of the thelodont scales found thus far in Australia come from nearshore or shallow water sediments (Fig. 1). The picture emerging from the study of Devonian thelodonts in Australia is one of turiniids, and possibly nikoliviids, living mostly as isolated populations in different parts of the continent. *Turinia australiensis* Gross (1971b) was fairly widespread in Early Devonian times (Turner *et al.* 1981, Turner 1982b) but other turiniid species were already separate from these, as in the Grampians and also in northern Queensland (Turner pers. obs.). By late Early Devonian and Middle Devonian times other turiniid species are present in the Georgina (Turner *et al.* 1981), Amadeus, and Arckaringa Basins (Young pers. comm., Long pers. comm., Turner pers. obs.) and in the Hatchery Creek (Young & Gorter 1981) and Broken River areas (Turner 1982c). By early Frasnian times only one thelodont population is known—in the Carnarvon Basin (Turner & Dring 1981). The separation of basins in the eastern part of Australia during the various Devonian orogenic events, discussed, for instance, by Cas (1983), probably created the right framework for turiniiform speciation.

AGE OF SILVERBAND FORMATION

On the purely sedimentary clues, the Grampians Group was considered as equivalent to Lower Devonian to Lower Carboniferous (Chapman 1917, footnote 2, Spencer-Jones 1965). The Grampians Group comprises predominantly non-marine quartzose sandstone, red siltstone and mudstone associated with basal acid volcanics of the Rocklands and Wickliffe Rhyolites. The sediments are intruded by granite, granodiorite and associated sills and dykes. Recent isotopic dating of the granodiorite gave an age of Early to Middle Devonian (Vandenberg *et al.* 1976). The dates provided for the Mafeking Granodiorite, which intrudes the lowermost Red Man Bluff Sandstones (the sediments just below the Silverbank Formation), were at an average 381.5 million years, around those of the supposed Siluro-Devonian boundary and earliest Devonian (Spencer-Jones 1976).

The primary interpretation of the fish remains from Unit 3 of the Silverband Formation given here supports the evidence from radioactive dating; that is, the Grampians Group is of Early to Middle Devonian age and not younger. On balance the faunal evidence favours an Early Devonian age.

SYSTEMATIC PALAEONTOLOGY

"Agnatha"

Subclass Thelodonti

Order Thelodontida

Family Turiniidae Obruchev 1964

Genus **Turinia** Traquair 1896

Remarks: For discussion of the attributes of the scales of this genus see Gross (1967) and Karatajute-Talimaa (1978); for description of the type species, *Turinia pagei*, see Traquair (1899), Stensiö (1964), and Turner (1982b). *Turinia* is known from the latest Silurian in Greenland and possibly in the Welsh Borderland into the early Upper Devonian (Frasnian) in Australia.

Turinia fuscina sp. nov.

Figs 2 B-H, K-U

1963 Elasmobranch Dermal Denticles, Talent & Spencer-Jones, p. 10, fig. 4.

1982a turiniid thelodont, Turner, p.117.

1984 *Turinia*? sp., Long & Turner, p. 235.

Etymology: In allusion to the trident-like shape of the crowns of trunk scales.

Diagnosis: Small to medium-sized thelodontidid scales; rounded head scales with a high-peaked crown of up to 12 radiating ribs which may bifurcate at the crown rim; elongate transitional scales with large undulating ribs deeply dissecting the crown; and tripartite or monolithic trunk scales with a flat central area and a pair of lateral segments separated by a shallow groove, ending in sharp posterior points. Ventral crown ribs present in some body scales. Shallow neck in all scales. Base relatively large and shallow in head and transitional scales. In trunk scales, the base is placed anteriorly and may be extended into a basal prong, or expanded laterally. Pulp canal may split into as many as three separate basal openings.

Material: Eighteen paratypes and possibly numerous other syntype scales embedded in samples of the Silverband Formation held in the Museum of Victoria, MV (NMV) "GSV" 54862-4, 8.

Locality: 6a of Talent & Spencer-Jones (1963), table 2.

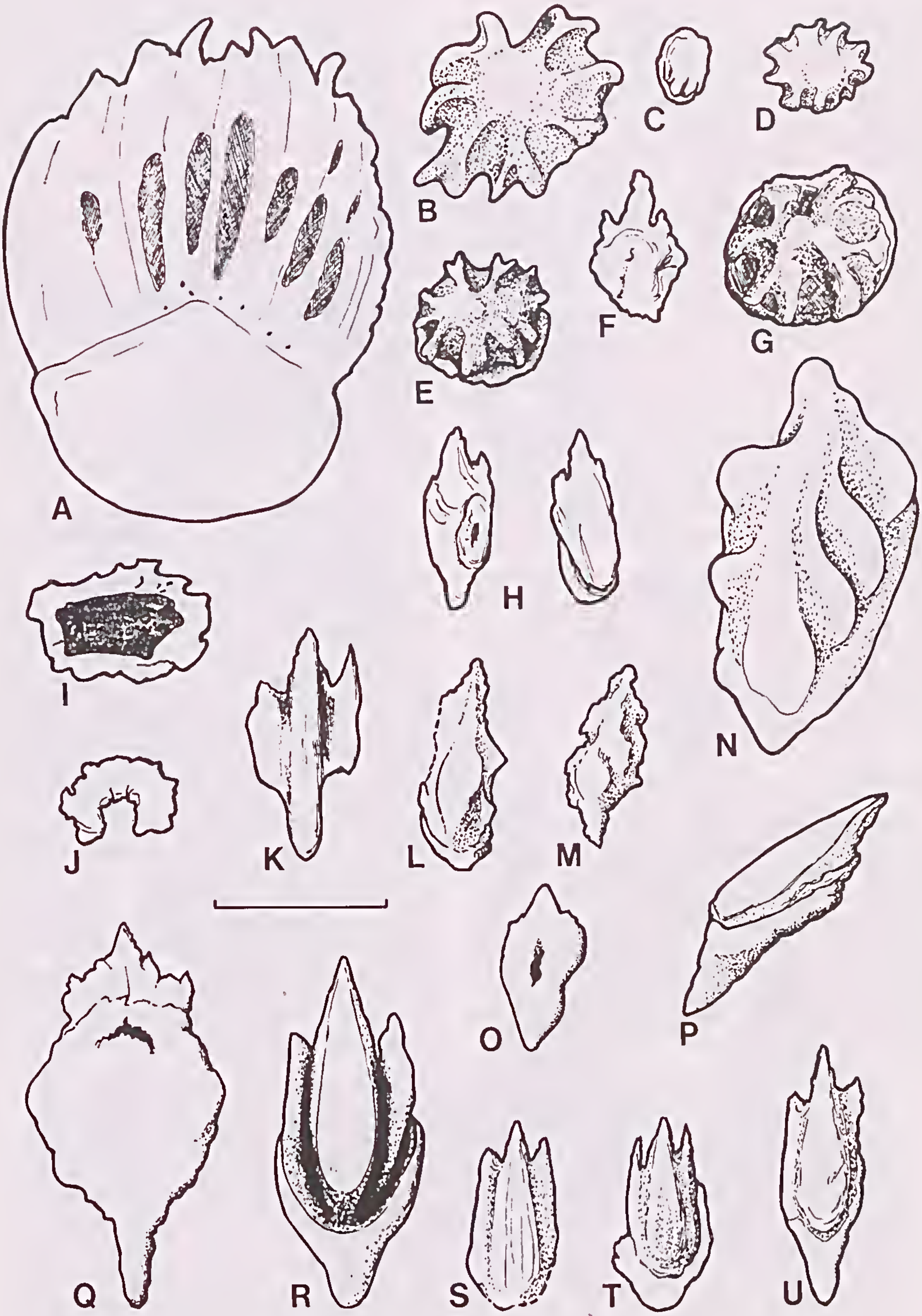
Remarks: All the scales are poorly preserved, white in colour and rather friable: many are cracked or broken. They are embedded in sandstone and can only be exposed by careful preparation with needles. No complete scales have been removed from the sediment and so it has not been possible to examine a scale 'in the round' or histologically. The figures represent parts of scales seen with the aid of the binocular microscope on the surface of the rock samples.

Description: The small scales are of the three main types typical of all thelodonts. There are rounded head scales, more elliptical transitional scales and lenticular and elongate trunk scales. Variations of the main types are thought to belong to special scales on the fins and tail, around the orifices and other small areas of the body.

Head scales are rounded and vary in length from 0.35-0.6 mm (fig. 2B, D, E, G). The overall shape of the crowns is dome-like. The crown rim is crenulated, with about 7 or 8 rounded ribs ascending towards the centre of the crown. These ribs can be bifurcated towards the crown rim so that a smaller number of ribs meets the smooth raised centre of the crown. The neck is low. The base is probably also low with a central pulp opening but this has not been observed in a head scale from the Silverband Formation. Smaller rounded scales, about 0.25 mm long, are probably special head or buccal scales (Fig. 2C).

Only one complete transitional scale has been observed (Fig. 2N). This is relatively large, 1.2 mm long, elliptical in outline with a high crown. There are rounded ribs ascending onto the relatively narrow top of the crown. The anterior rib is slightly bifurcate, and there are two or three ribs on either side merging into the posterior spur of the crown. The neck is low. The base is large and elliptical. There is one other poorly-preserved

Fig. 2—Devonian vertebrate microremains from the Silverband Fm., Grampians, western Victoria. A, I, Acanthodian? remains. A, Acanthodian? scale, *Gomphonchus (Poracanthodes)*? sp. horizontal section, NMV/54864.1. I, Acanthodian? spine in cross-section, NMV/54868.1. B-H, J-U, *Turinia fuscina* sp. nov. B, head scale, dorsal view, NMV/54864.2. C, head scale, dorsal view, NMV/54862.1. D, head scale, dorsal view, NMV/54862.2. E, head scale, dorsal view, NMV/54862a.1. F, body scale, ventral view, NMV/54863.1. G, head scale, dorsal view, NMV/54863.2. H, body scale, postero-lateral and dorsal views, NMV/54862.3. J, scale in cross-section, NMV/54868.2. K, body scale, dorsal view of crown, NMV/54862a.2. L, body scale, dorsal view, NMV/54862.4. M, transitional scale, NMV/54862.5. N, transitional scale, NMV/54862.6. O, base only, ventral view, NMV/54868.3. P, body scale, lateral view, NMV/54862.6. Q, body scale, ventral view, NMV/54862a.3. R, body scale, dorsal view, NMV/54862.7. S, body scale, dorsal view, NMV/54868.4. T, body scale, dorsal view, NMV/54862.8. U, body scale, dorsal view, NMV/54862.9.
Scale bar = 0.5 mm.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scale which is probably also a transitional scale (Fig. 2M).

Trunk scales observed range in size from 0.5 to 1.3 mm (Fig. 2F, H, L, P-Q, R-U). Those figured by Talent and Spencer-Jones (1963, fig. 4A-C) show the typical trident shape of the crown. Most have an elongate, tripartite crown with a raised central platform, which is flat (Fig. 2P, R, U) or slightly concave (Fig. 2S, T). Lateral segments are separated from the central area by a shallow trough (Fig. 2R, S, T). The lateral segments and the central area apparently elongate into three prominent posterior points, the central one being the longest (Fig. 2K?, R-U). One scale seen in lateral view is apparently devoid of lateral crown segments and has one short posterior rib descending onto the smooth neck (Fig. 2P). One or two scales seem to exhibit short curved riblets on the postero-ventral surface of the crown extending from the posterior crown points to abut on the neck-base line (Fig. 2H, Q). The neck is shallow and forms a distinct trough anterior to the crown rim. The base is large and can be expanded laterally (Fig. 2Q). The pulp opening is central or posteriorly-placed (Fig. 2H, O, Q) and can divide into as many as three separate openings (Fig. 2F). Several body scales exhibit short to long horizontal prongs on the anterior of the base (Fig. 2H, Q-R, U).

Broken scales (Fig. 2J-H) or scales preserved in basal view (Fig. 2O, Q) reveal histological features. They apparently agree with those of other turiniiform species (see e.g. Gross 1967, Turner & Dring 1981). The crown and neck are formed of simple orthodentine and the base is penetrated by one main pulp canal, which may split into a few basal openings.

DISCUSSION

The scales referred here to a new species, *Turinia fuscina*, seem to be closest to the type *Turinia pagei* (Powrie 1870). The type species *sensu stricto* is found in latest Silurian (Upper Downtonian) to Siegenian in Europe and North America (Turner 1973, 1984). It has been recorded in Australia in the Devonian Cravens Peak Beds (Turner *et al.* 1981), although study of new material from the Georgina Basin suggests that some of the turiniid scales from the Cravens Peak Beds are better referred to a new species (Turner 1984).

The head and transitional scales seen in the Silverband Formation are very similar to all turiniiform and other thelodont head scales. Thelodonts and, for that matter, many shark groups have rounded head scales with undulating crown margins and radiating ribs. The crown ribs on the Silverband head scales do have a tendency to bifurcate and this character is seen in *Australolepis seddoni* Turner & Dring 1981 from the Frasnian Gneudna Formation and in some of the turiniid head scales from the Georgina and Amadeus material. The trunk scales, however, are more characteristic. These have flat monolithic central crown segments exactly like those in *Turinia pagei* and *Turinia polita* Karatajute-Talimaa 1978 which are found often in association in the Dittonian sediments of the Welsh Borderland, France and Podolia. The Silverband trunk scales differ in being noticeably tripartite. This feature is known, though not so extreme, in *T. pagei* scales. Scales similar to those of *T. pagei* and *T. polita* are also present in the Tumblong oolite of New South Wales which is considered to be Lower Devonian (Pickett *et al.* 1985); some of these scales are very like those of the new species.

The scales from the Silverband Formation are unlike the trunk scales of any contemporary or younger turiniiform scales as yet described—*T. australiensis* Gross 1971b from the Siegenian/Emsian and possibly younger of Australia (Turner *et al.* 1981, Turner 1982b), *Turinia* sp. nov. from the Georgina Basin and the Amadeus Basin (Young coll.), *Turinia* sp., "cf. *T. hutkensis*" from the Hatchery Creek Conglomerate Group of New South Wales (Eiflian/Givetian) (Young & Gorter 1981) and the Broken River Formation of Queensland (Turner 1984), *Turinia hutkensis* Blieck & Goujet (1978) from the Middle-Late Devonian of Iran, *Turinia* sp. nov. from the Broken River Formation of Queensland (Turner pers. obs.), *Turinia* sp. from the Arckaringa Basin of South Australia (Long, Young & Turner in prep.), *Turinia* spp. from the Middle Devonian of west Yunnan (Wang *et al.* in press), Antarctica (Turner & Young pers. obs.), and the Lower or Middle Devonian of Thailand? (Blieck *et al.* 1984), and South America (Goujet *et al.* 1984), and *Australolepis (Turinia?) seddoni* from the Gneudna Formation of Western Australia. All of these scales have more sculptured crowns with fine ribbing on the main

Fig. 3—Comparison of a selection of trunk scales from some of the known turiniid populations. A. *Turinia pagei* (Powrie 1870) Dittonian, Welsh Borderland (Turner coll.). B, *Turinia pagei* Dittonian, Podolia (from Karatajute-Talimaa 1978). C, *Turinia pagei* Dittonian, Welsh Borderland (Turner coll.). D, *Turinia polita* Karatajute-Talimaa 1978, Dittonian, Podolia (after Karatajute-Talimaa 1978). E, *Turinia polita* Dittonian, France (after Goujet & Blieck 1979). F, *Turinia fuscina* sp. nov. L? Devonian, Victoria (this paper). G, *Turinia australiensis* Emsian, Belvedere Formation, NSW (Pickett coll.). H, *Turinia australiensis* holotype, L. Devonian?, Western Australia (from Gross 1971b). I, *Turinia* sp. Emsian? Cravens Peak Beds, Georgina Basin, Queensland (after Turner *et al.* 1981). J, *Turinia hutkensis*, M. Devonian, Iran (after Blieck & Goujet 1978). K, *Turinia* sp. Cravens Peak Beds (after Turner *et al.* 1981). L, *Turinia pagei* Dittonian, Welsh Borderland (Turner coll.). M, *Turinia* sp. Cravens Peak Beds (after Turner *et al.* 1981). N, *Turinia* sp. M. Devonian, Hatchery Creek Conglomerate Group, NSW (after Young & Gorter 1981). O, *Australolepis seddoni* Turner & Dring 1981, Frasnian, Gneudna Formation, Western Australia (after Turner & Dring 1981). P, *Australolepis seddoni* Gneudna Formation (after Turner & Dring 1981). Not to scale: all turiniid thelodont scales depicted are within length range of 0.5-2.0 mm.


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segments, extra lappets on the lateral segments, double ribs extending the full length of the crown, or ribs deeply dissecting the crown. Some even have small upturned hooks on the lateral crown/neck surface. A comparison of some *Turinia* trunk scales is shown in Fig. 3. The significance of these characters to the functional morphology or phylogeny of turiniiform thelodontids is not certain, but the wealth of new thelodont, especially turiniiform, material obtained in the last few years suggests that an analysis of all scale characters will prove helpful in understanding thelodont phylogeny. A preliminary study of such characters has been undertaken (Turner 1984) and will be presented in a future publication.

Pisces

Osteichthyes?
Subclass Acanthodii?
Family Climatiidae Berg 1940?
climatiid? cf. **Sinacanthus** P'an 1957
Fig. 2 1

1917 *Physonemus micracanthus* sp. nov. Chapman, pp. 84-84, pl. 5, figs 1-3.
1917 *Physonemus attenuatus* Davis; Chapman, pp. 85-86, pl. 5, fig. 4.
1917 *Physonemus* sp. Chapman, p. 86.
1957 *Physonemus? micracanthus* and cf. *Erismacanthus*, Baird, p. 1012.
1958 *Physonemus* (*P. attenuatus* and *P. micracanthus* Chapman, 1917), Hills, p. 91.
1963 *'Physonemus' micracanthus* Chapman, Talent & Spencer-Jones, p. 7, pl. 11, figs 4-8; fig 3.
1982 acanthodian spines, Turner, p. 117.
1984 acanthodian remains, Long & Turner, p. 237.

Material: See Talent and Spencer-Jones (1963). Ten specimens in the Museum of Victoria (P14363-5, P34318 type material, "GSV" 5447a-b, 13100, 57826, 57827).

Localities: 1, 2, 3, 4, 4a, 12 of Talent & Spencer-Jones (1963), table 2.

Remarks: None of the fin spines is well-preserved and there are no signs of an unornamented shaft on any of them. This would seem to rule out the possibility that they are shark spines. The few specimens available resemble *Sinacanthus* spines found in various parts of China, where at least four species have been recorded from Silurian and Early Devonian sediments (P'an 1964, Liu 1973, P'an & Liu 1975, Li 1980, Wang *et al.* 1980). The Silverband spines seem very like those of *Sinacanthus triangulatus* P'an, Wang and Liu (1975) from the Lower Devonian of South China.

One specimen (Talent & Spencer-Jones 1963, pl. 11, fig. 7) is definitely more nodose than the others illustrated. This specimen might belong to a shark such as *Antarctilamna* Young (1982) and not to an acanthodian. *Antarctilamna* was a xenacanthiid shark from the Middle Devonian of Antarctica and New South Wales. However, the specimen also resembles the acanthodian spine form called *Neoasiacanthus* by Wang *et al.* (1980). *Neoasiacanthus* is found in association with *Sinacanthus* in the mid to Late Silurian Fentou Formation of east China (Wang *et al.* 1980, Liu 1983). Other nodose climatiid(?) spines from the western MacDonnell Ranges of the Amadeus Basin are discussed and figured by Young (1985, fig. 81); these came from the Harajica Sandstone Member of the Parke Siltstone which Young considered to be of Givetian to Frasnian age.

Family Ischnacanthidae Berg 1940?
Genus **Gomphonchus** Gross 1971?
Gomphonchus? sp.
Fig. 2A

1963 Elasmobranch Dermal Denticles, Talent & Spencer-Jones, p. 10.
1963 Elasmobranch Teeth, Talent & Spencer-Jones, p. 10, pl. 11, fig. 2, 3, 8.
1982 acanthodian tooth whorls, Turner, p. 117.
1984 cf. *Paracanthodes*, Long & Turner, p. 240 (*Poracanthodes*, in error).

Material: Two scales and three tooth whorls noted so far in rock samples housed in the Museum of Victoria ("GSV" 58218-9, 54862, 54864, 54868).

Localities: 2, 3, 6a of Talent & Spencer-Jones (1963), table 2.

Remarks: Gross (1957, 1971) studied acanthodian tooth whorls in great detail. He showed that some climatiids such as *Nostolepis* had tooth whorls with flattened transverse blades whereas those of the ischnacanthids such as *Gomphonchus* had stabbing cusps.

Some other Devonian fishes (onychodontid crossopterygians and, perhaps, some early sharks) also possessed tooth whorls and cannot be ruled out as the source of the Silverband specimens. However, the tooth whorls figured by Talent and Spencer-Jones appear very like ones referred to *Gomphonchus* (Gross 1957, Denison 1979).

Two large scales, one figured (Fig. 2A), are seen in natural horizontal section. These are very similar to those called *Poracanthodes*, which Gross (1957) thought were special lateral line scales of *Gomphonchus*. However the possibility that these larger scales are those of a shark, *Antarctilamna* (Young 1982) for example, cannot be ruled out until more Silverband scale material is available for study and until scales of that shark genus are examined histologically. One scale seen on slab 54868 has a crown of curved angled ribs like those of the trunk scales of *Antarctilamna* portrayed by Young (1982, pl. 87, figs 6-7).

Discovery of acanthodian jawbones, for example, in the Silverband Formation would help to resolve the identification with more certainty. Scales, spines and teeth of climatiids and ischnacanthids of *Nostolepis* and *Gomphonchus* types are found elsewhere in the Upper Silurian and Lower Devonian of Australia (Long & Turner 1984). These forms are not known in sediments younger than Siegenian.

SUMMARY OF SILVERBAND FAUNA

On the one hand the Silverband Formation fauna can be interpreted as follows:

Agnatha: Thelodonti *Turinia fuscina* sp. nov.

Osteichthyes: Acanthodii ischnacanthiid *Poracanthodes/Gomphonchus* sp. climatiid? *cf. Sinacanthus*

This interpretation of the fauna appears to me to be the most likely assessment based on the morphology of the turiniid scales and the association of the thelodont and acanthodian remains. It supports a Lower Devonian age for Unit 3 of the Silverband Formation.

If, however, it could be confirmed that the fin spines, tooth whorls and larger scales derive from sharks such as *Antarctilamna* Young 1982, or from acanthodians such as those found in the Amadeus Basin (Young 1985), then the Silverband Formation is younger, possibly late Middle Devonian or early Frasnian. This would mean that *Turinia fuscina* is one of the youngest thelodont species. Turiniids are known to be associated with sharks in the late Middle Devonian of Antarctica (Young & Turner pers. obs.). The presence of turiniiform thelodont scales puts an upper limit of early Frasnian and a lower limit of late Pridolian/early Gedinnian on the Silverband Formation.

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